PUBLISHED QUARTERLY BY UTAH GEOLOGICAL AND MINERAL SURVEY

SURVEY NOTES

VOL. 17, NO. 4 SERVICE TO THE STATE OF UTAH WINTER 1984

UTAH TAR SANDS

By RAY KERNS

THE words *tar, asphalt, bitumen, pitch,* and *heavy oil* often have been used to refer to highly viscous liquid, semi-solid, or solid, naturally occurring hydrocarbon substances. The word *bitumen* originated with the Romans and included all the various types of natural hydrocarbons. In its modern, common, useage it is understood to be synonymous with petroleum in both its liquid and solid forms. Commercially, the word *bitumen* refers only to the solid and semisolid hydrocarbon compounds.


OIL SEEP — WHITE CANYON FLAT

The definition of *asphalt* varies but, according to the American Society of Testing Materials, asphalts are black to dark-brown solid or semisolid materials which liquefy when heated, in which the predominating constituents are bitumens which occur in nature or are derived by the partial evaporation and distillation of petroleum. Most definitions of *tar* tend to relate it to the residue that results from the destructive distillation of wood, peat, or lignite. In the natural sense it has come to mean asphalt or bitumen but generally, the word *tar* is used when the substance has less of a solid consistency and is more of a heavy, viscous oil. Table 1 (page 3) shows the relationship of some of the more common and not-so-common terms used to refer to natural hydrocarbon substances.

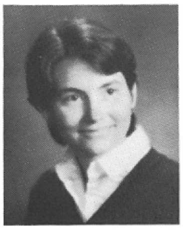
In 1980, the U.S. Department of Energy redefined tar sands as any consolidated or unconsolidated rock (other than coal, oil shale, or gilsonite) that contains hydrocarbons (bitumen) with a gas-free viscosity greater than 10,000 centipoise, at original reservoir temperature. The Bureau of Land Management has added "or is produced by mining or quarrying" to the definition (National Research Council, 1983). Because of the similarities in composition between hydrocarbons in the near-surface accumulations and the more deeply buried petroleum in the nearby petroliferous provinces, UGMS geologists have referred to the so-called tar sand deposits of Utah as *oil-impregnated sandstones*. However, with the use of the term "tar sands" in the Combined Hydrocarbon Leasing Act, the DOE/BLM definition, and the continued preference in useage by the Interstate Oil Compact Commission and the National Research Council, it would appear that the term *tar sand(s)* will be in popular use for some time.

COMPOSITION OF PETROLEUM

Petroleum (and bitumen) is composed almost entirely of organic compounds known as hydrocarbons. As the name implies, these are composed predominantly of carbon (80-88 percent) and hydrogen (10-15 percent). The chemical properties, physical behavior, and chemical compositions of these substances are highly complex and become increasingly complicated when they are encountered as mixtures of many different compounds as they are found in the natural state.

The simplest hydrocarbon molecule is methane (CH_4) which is the major component of natural gas. The complicating aspects of hydrocarbon (and organic) chemistry are the ability and tendency for carbon to form chemical bonds to other carbon atoms. This gives rise to a myriad of structural and geometric shapes and sizes of the molecules. The sim-

(see page 4)



FROM THE DIRECTOR'S DESK

Preparing for the Events of 1984

THE floods, mudflows, landslides, high ground water, and rise of several lakes during 1983 kept the UGMS hazard geologists very busy last year and there is ample evidence that most of these phenomena will plague the state in 1984. Snowpack is heavy in the high country over most of the State. The ground is saturated with water and slopes that became destabilized last year are even more susceptible to failure this year. High ground-water conditions in the closed basins of western Utah have been aggravated by a wet winter resulting in "surfacing sewage" from septic systems that were constructed without sufficient separation from the water table. The Great Salt Lake continues on its rampage . . . having had its greatest historic seasonal rise in 1982-83 and its smallest historic seasonal decline in the summer of 1983, it has continued to rise at a greater than average rate in the winter and early spring of 1983-84.

It is still too soon to tell whether the combination of climatic conditions that caused the mudflows in Davis/Weber County watersheds in 1983 will be repeated in 1984. However, even if the snowmelt is early and relatively gradual, we expect landslides to occur in the same general areas as they did last year and in other areas which have had unusually heavy snowpack.

RESPONSE

This year State government is better prepared because we have learned so much from the 1983 experience. Comprehensive Emergency Management coordinates response activities, acts as the center through which information passes, issues Statewide warnings and alerts, and is the center for up-to-date information. The UGMS has been designated as the lead agency for providing geologic advice and service to local and state entities. We are to respond to reports of hazards; evaluate the hazards and risks associated with them; field check and document the hazards; work directly with local government technical teams to determine whether a hazard watch or evacuation is needed; coordinate volunteer geologists' efforts to identify and monitor landslides; keep informed of Federal and other State agencies' geologic activities, including research; and keep Comprehensive Emergency Management and the Department of Natural Resources well informed.

Other governmental entities have related responsibilities: the Division of Water Rights field checks dams; Federal land-management agencies identify geologic hazards and facilities at risk on Federal lands; the Department of Transportation copes with the construction and maintenance problems caused by landslides; and local government officials take actions to protect lakes and property. In 1983, U.S. Geological Survey geologists responded to our requests for assistance and supplemented the UGMS efforts as well as working on additional projects of their own.

All this costs money. The Thistle landslide is the nation's most expensive landslide ($200 million). The mud flows and floods in Weber and Davis Counties resulted in the complete destruction of several homes and damage to hundreds of others. Many individuals and businesses were hurt financially. But much of the several-hundred-million-dollar cost of the events of 1983 will be borne by Federal, State, and local governments . . . as will the costs of the events of 1984.

Landslides occur in most areas of the country and the nationwide losses are staggering: two billion dollars and 25 to 50 lives annually. Much, if not most, landslide-caused property losses should be avoidable, preventable, or controllable, and virtually all landslide-caused deaths and injuries are preventable. Clearly this is an area where geological and engineering research can effectively be applied. Yet it appears that funding may be decreasing rather than increasing for research to understand landslide processes, assess landslide risks, develop prediction and early warning techniques, identify landslide areas, and transfer these results to the public. The events of 1984 in Utah will provide an opportunity to "capture" landslides of all sorts. Utah State University, the University of Utah, the UGMS, and the USGS all have proposed research projects, and some experiments are presently underway. Last year we learned how to react to landslide hazards. This year we should learn more about ground failures so we can, in the future, do more than react. Ground failure research is in urgent need of greater support.

Genevieve Atwood

GEOLOGIC HAZARDS

By BRUCE N. KALISER

LANDSLIDES — in December 1983, another movement of Lake Bonneville deltaic sediments occurred on the north bluff of the Logan River. Earlier in the year there had been other rapid earth failures which placed sediment into a major canal causing blockage. Since water doesn't flow in the canal in December, the risk was considerably reduced; nevertheless, the State highway which enters Logan Canyon is threatened. This last event, it is significant to note, was not associated with prior failures elsewhere along the bluff.

In mid-February a small slide occurred along the banks of the Little Bear River, not far from Paradise, Cache County. Some damage was done to private pastureland. The material in this slide was apparently dry, with no seep or springs in the vicinity. In the spring of 1983, another slide of the same approximate dimensions occurred about 1/2 mile away on the same river bluff.

Also on March 7, an unconfirmed small slide was reported just upstream from the mouth of Blacksmith Fork Canyon on the south side, in Cache County.

North of the State line in Idaho, a 300-foot-long by 60-foot-wide slide in Salt Lake Group sandstone and residual sandy soil occurred on March 7th. The City of Preston's culinary water line was severed and residents were forced to boil their drinking water. The water line originates at Berquist Springs in Cub River Canyon, 13 miles from city storage tanks. Indications are that the slide is immediately downslope from an old spring area.

On March 8th, the writer observed four small shallow movements on the north flank of the great Thistle Landslide (of April, 1983). These individual failures were not indicative of movement of the greater tongue of earth comprising the major landslide.

Detached rock masses along the new State road cuts on Billies Mountain have moved throughout the winter. On at least four occasions, traffic on this new road through Spanish Fork Canyon has had to be detained; the most recent occasion was over the March 16-18 weekend. Faulting and diverse lithologies are mainly the cause of the severe problems here.

Periodic survey notes examined for two Denver and Rio Grande Railroad fill sections for new trackage in the vicinity of Thistle indicate that there were horizontal and vertical movements between the months of November and March and in December with almost no additional movement between the 5th of January and March 2nd.

THE WEEK of February 27, General Mathews of the Utah National Guard reported having seen a rather continuous ground crack through snow and into soil at high elevation just west of the divide and north of the Bountiful Peak radar facility in Davis County. By the time of the season's first aerial reconnaissance flight on March 16th, fresh snowfall may have obscured these features. The U.S. Forest Service personnel observed only quite small shallow slides near elevations of 5100 feet to 5300 feet on Facer Creek in Box Elder County and Rudd, Hobbs, North Fork (Kays), and Shepard Creeks in Davis County.

On March 8, Don Mabey of the UGMS noted through binoculars what appeared to be new shallow movement of the Stone Creek debris slide, east of Bountiful, Davis County.

Snow slides were significant occurrences in December and March, especially in Utah County. Two slides occurred on December 25th in Provo Canyon, the larger of which removed a cabin and scattered it over a 100-foot area. The slide came from the south side of Provo Canyon, originating on an interflow slope near the south Fork, in the Vivian Park area where there are some two dozen or more homes. The slide, after striking the unoccupied home, crossed a road where it deposited some 12 feet of snow.

On December 26th, in the Hobble Creek drainage in Utah County, a snow slide moved a new home (valued at approximately $60,000) off its foundations and struck several vehicles. It traveled down a south-facing slope on the flank of Pole Haven Mountain, into the Holiday Hills subdivision area.

Also in late December, three or four snow slides occurred on the west facing slopes of the Wasatch Range between Provo and Springville. In one or more of these, rock is also reported to have been transported along with the snow.

In early March, more snow slides occurred in Provo and Ogden Canyons, blocking traffic. The Ogden Canyon slide was in the vicinity of Pineview Reservoir.

Recent archival work by the writer has revealed the relative abundance of snowslides in Provo Canyon, with events recorded in 1877, 1924, 1929, 1931, 1932, 1936, 1952, and 1978. A boy scout was killed in a snowslide in Rock Canyon, Provo, in February of 1968; three others narrowly escaped. Landslides have also been in relative abundance in Provo Canyon.

The unusually **high water table** has been blamed for recent damage to buildings in various Wasatch Front communities. Salt Lake City and Lehi in Utah County have had old buildings crack this winter but it is unconfirmed whether, in fact, the rising water table has been responsible. ■

Readers are asked to correspond with Bruce N. Kaliser, 581-6831, with respect to any and all observations relative to geologic hazards, preferably as soon after the event as possible.

IN THIS ISSUE

Utah Tar Sands 1
From the Director's Desk 2
Geologic Hazards 3
New Earthquake Program 10
New Publications 11
Annual Index 11
UGMS Staff Changes 12
Great Salt Lake Level 12

(Continued from Page 1)

plest geometric forms are the straight-chain hydrocarbons, or normal-paraffin group. The simpler compounds of this group are methane (mentioned above), ethane (C_2H_6), propane (C_3H_8), and butane (C_4h_{10}). Longer-chain hydrocarbons are commonly found in the so-called petroleum condensates because they may be produced as gases from higher temperature, deeply buried reservoirs, but quickly condense to a liquid form at earth-surface temperatures.

Under certain conditions, a carbon atom may bond to more than one other carbon atom. When this occurs, the molecule develops a branching geometry. One of these groups comprises the branched-chain paraffins. The general formula C_nH_{2n+2} applies to both paraffin groups.

Under certain chemical conditions of formation of paraffin molecules, the ends may link through carbon-to-carbon bonds to form rings. These molecules have the general formula C_nH_{2n} and, beginning with C_3H_6 (cyclo- propane), constitute an important group called the *cycloparaffins* or *naphthenes*. Another type of ring-structured compound forms when adjacent and alternating carbon pairs form double bonds. This gives rise to a group of organic compounds known as aromatics of which benzene, with the formula C_6H_6, is the simplest member. This group contains very complex members and is characterized by its strong odors, chemical reactivity, and strength as solvents. Figure 1 shows simplified diagrams of some of the hydrocarbon molecules.

THE physical properties of the hydrocarbon compounds are very much determined by the size of the molecules. In the general sense, within each group those compounds with larger molecules are more viscous, have higher densities, higher melting points, and higher boiling points. The compounds with the smallest molecules will exist as gasses at normal earth-surface temperatures and pressures. In the intermediate sizes, there are groups of compounds with larger molecular sizes which exist as liquids under similar conditions. The largest molecules in each group exist as solids at earth-surface conditions. It is difficult to generalize as to what the exact limitations of physical state are in relation to the carbon numbers in each group because all natural bitumens are complicated mixtures and the interaction of the various molecules creates a very complicated physical-chemical system.

TABLE 1. Some of the naturally occurring hydrocarbons.

Bitumens	Asphaltites
Liquid Petroleum	Gilsonite
Paraffin base	Grahamite
Asphalt base	**Pyrobitumens***
Mixed base	Kerogen
Native Mineral Waxes	Lignite
Ozokerite	Bituminous coal
Montan Wax	
Native Asphalts	

*Generally the infusible and insoluble hydrocarbons or hydrocarbon-related compounds.

Petroleum is classified according to its composition into three types: paraffin base, asphalt base, and mixed base. Paraffin-base crude oils contain a preponderance of paraffin compounds and leave a residue of wax when distilled. Asphalt-base crude oils are composed of cycloparaffin compounds and when distilled leave a residue of asphalt. Uinta Basin crude oils and tars are essentially paraffin base whereas the bitumens in the southeastern part of Utah are mostly an asphalt base.

ORIGIN OF PETROLEUM AND TAR

The processes of formation of bitumen in Utah tar sands are the same as those which are responsible for the formation of petroleum. There are four basic steps in the genesis of petroleum and subsequent accumulations. This process is illustrated in figure 2.

Step 1. The origin of hydrocarbon begins with the accumulation of organic matter such as plants, algae, plankton, etc. The sedimentary environment must be such that the organic material is preserved in the sediment. These conditions are usually provided by rapid burial and/or chemically reducing conditions.

Step 2. The original organic matter must undergo chemical changes to convert it into the hydrocarbons that are found in petroleum and tar. The original organic material is composed of complex hydrocarbon-like lipids (which includes fats, waxes and related compounds), carbohydrates (sugars, starches, and cellulose), and proteins (amino acids). Many theories have been proposed to account for the chemical origin of petroleum but the processes are not yet totally understood. However, two agents which seem to be important to the process are the increased temperature and pressure due to burial. The chemical action of acids, oxygen, and water is also important as is the biological activity of bacteria. Some theories also promote the importance of clay and other inorganic minerals which act as catalysts. The kerogen of oil shales is formed in the early stages of conversion of the primary organic matter to the petroleum hydrocarbon compounds.

Step 3. When the complex molecules of the original organic matter and generated kerogen have been sufficiently altered to petroleum hydrocarbons, the droplets of bitumen acquire a mobility due to decreased viscosity (increased fluidity) which allows them to migrate out of the source bed.

Step 4. If the permeability of the rocks is adequate and pressure differences are sufficient, the petroleum will move through carrier beds until it reaches a permeability barrier. For example, it may migrate upward through a sandstone bed into a structural trap (such as an anticline) that is overlain by an impermeable shale. Stratigraphic traps may also be caused by permeability barriers created by facies changes which inhibit updip migration. Even after entrapment, the chemical

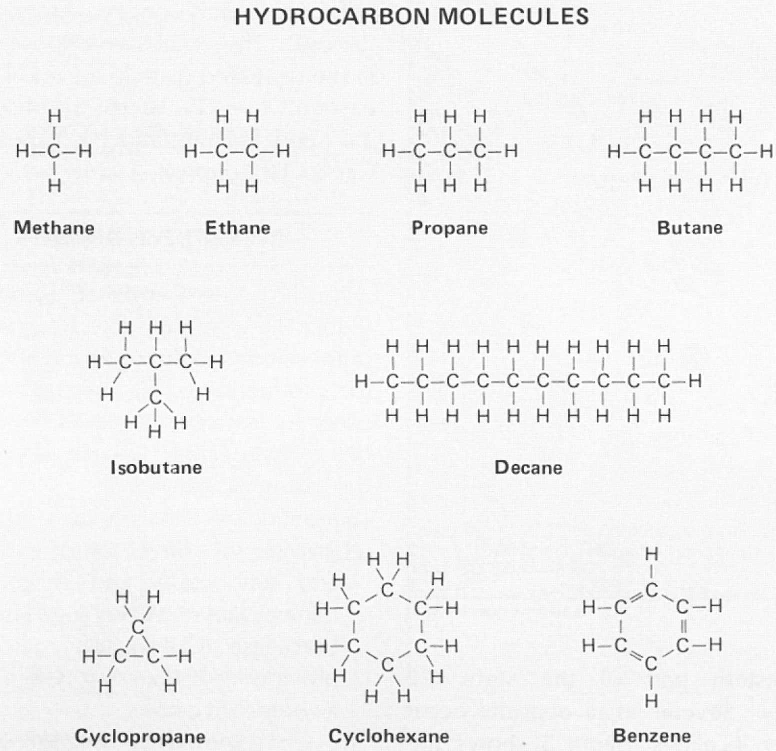


FIGURE 1.

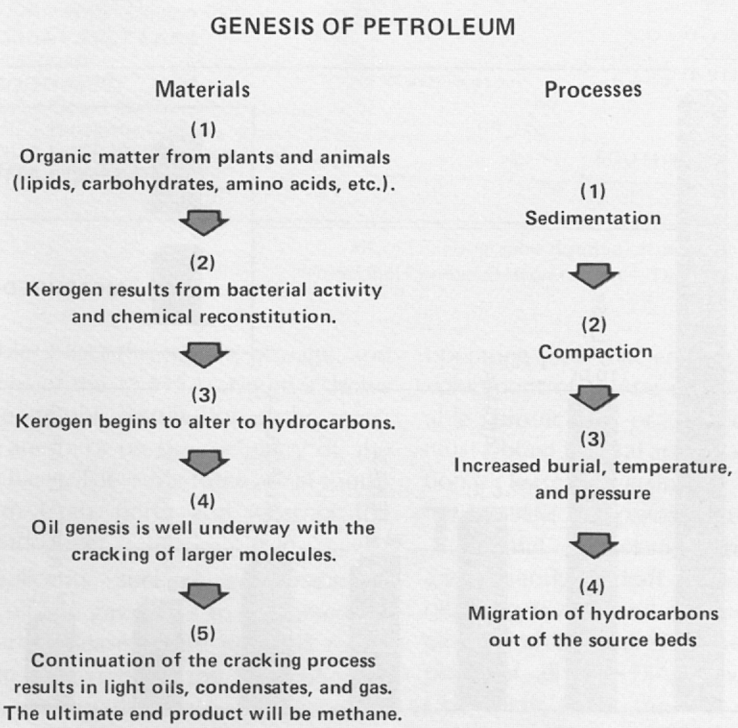


FIGURE 2.

changes in the hydrocarbons may continue to occur. Under the static physical conditions of the reservoir, separation of gas and liquid phases occurs.

SPECIFICALLY, with respect to tar sand genesis, as the hydrocarbons migrate upward toward the surface other changes may take place. Because the fluids are mixtures of hydrocarbons with different physical properties, a separation of phases may occur as the petroleum passes through carrier beds which become gradually more impermeable or when a trap is reached which is impermeable to only the less fluid phases. In the general sense, the hydrocarbons with smaller molecules have characteristically lower melting points and boiling points than those with larger molecules. The branched-chain paraffin compounds also have lower boiling and melting points than straight-chain hydrocarbons of the same carbon atom number. The cycloparaffins also have properties that vary in a similar manner as a function of molecule size and complexity. Members of the cycloparaffin group have higher boiling points, melting points, and densities than the normal and branched hydrocarbon compounds with the same carbon members. The properties of solutions and mixtures of liquids and gasses is ruled by complicated physical-chemical relationships and cannot be adequately dealt with in this discussion but, in general, as the petroleum moves through or becomes entrapped in a semi-restrictive layer, the shorter-chain and smaller molecules in a more fluid or even gaseous state will have a tendency to "outrun" or separate from the less fluid and less mobile larger and more complex molecules. This separation can also be enhanced by a temperature increase causing a fractional distillation process to occur, and it can also happen as a result of cooling. As the fluid migrates upward toward the earth's surface, the larger-molecule hydrocarbons will condense, solidify, or become more viscous, and their progress will be retarded with respect to the more volatile, smaller-molecule hydrocarbons. The ultimate result, if there is no trap or barrier, is the loss of the volatile substances to the atmosphere and all that is left behind in the carrier

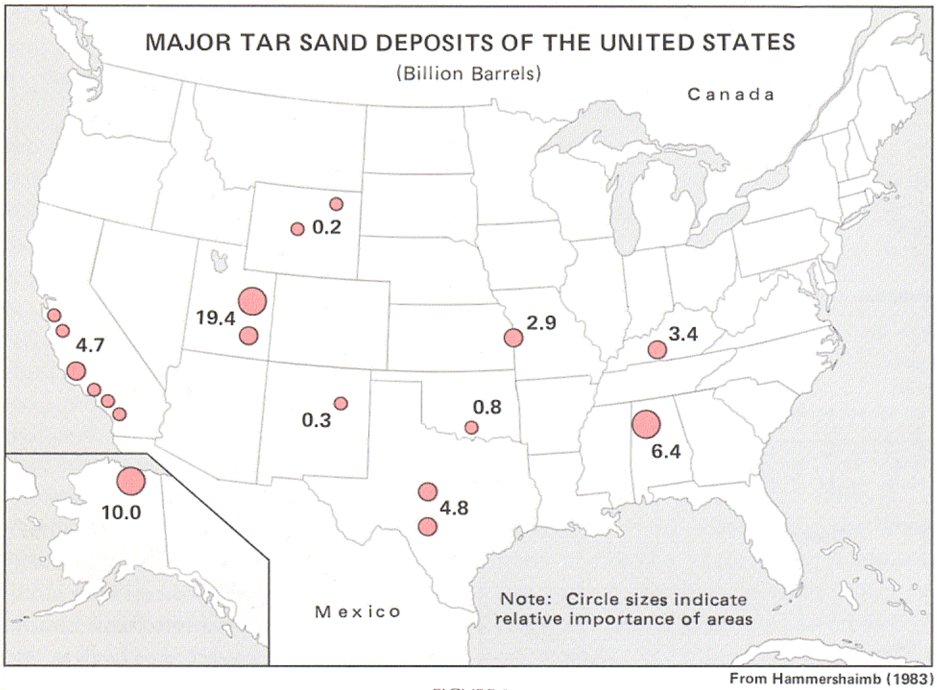


FIGURE 3.

sandstone is a residue of waxy and/or asphaltic hydrocarbons with high densities, low viscosities, and high melting points, that is known as tar.

DISTRIBUTION OF UTAH TAR SANDS

United States

ACCORDING to Hammershaimb (1983), the total tar sand resource of the United States is 54 billion barrels. This is divided into measured resources in-place in major deposits of 22 billion barrels and speculative resources in-place estimated at 32 billion barrels. Figure 3 shows the geographic distribution of the U.S. tar sand resources by state and areas within the states. Figure 4 is a graphical display of the distribution of tar sand resources by State and classification.

Utah

The total tar sand resource of Utah, as reported by various recent studies, ranges from 19.4 to 29.2 billion barrels of measured and estimated recoverable oil in place.

This occurs in 53 deposits of oil-impregnated rock (tar sands) in Utah as defined on UGMS Map 47 (Ritzma, 1979). These are found principally in two areas: the Uinta Basin of northeastern Utah (25 deposits) and the central southeastern part of the State (22 deposits). Several small deposits occur in other localities. Figure 5 shows the geographic distribution of the more important deposits. According to Campbell and Ritzma (1979), more than 96 percent of the oil in place occurs in six giant deposits. Four of these deposits occur in the Uinta Basin and are the P.R. Spring, Hill Creek, Sunnyside, and Asphalt Ridge deposits. The other two deposits occur in the dissected plateau region of southeastern Utah. The largest of these is the Tar Sand Triangle and the other is the Circle Cliffs' deposit.

RECENT DEVELOPMENTS

In 1981, the Combined Leasing Act (Public Law 97-78) was enacted. The purpose was "to facilitate and encourage the production of oil from tar sand and other hydrocarbon deposits." The Combined Hydrocarbon Leasing Act contains the following features:

(1) redefine oil to include tar sand;
(2) provide for conversion of existing oil and gas leases and certain valid mining claims to Combined Hydrocarbon Leases (CHLs); and
(3) provide for issuance of new CHLs on a competitive basis.

The CHLs would be offered in areas designated by Congress as Special Tar Sand Areas (STSAs). There are 11 STSAs referred to in the Act. They are all located in Utah.

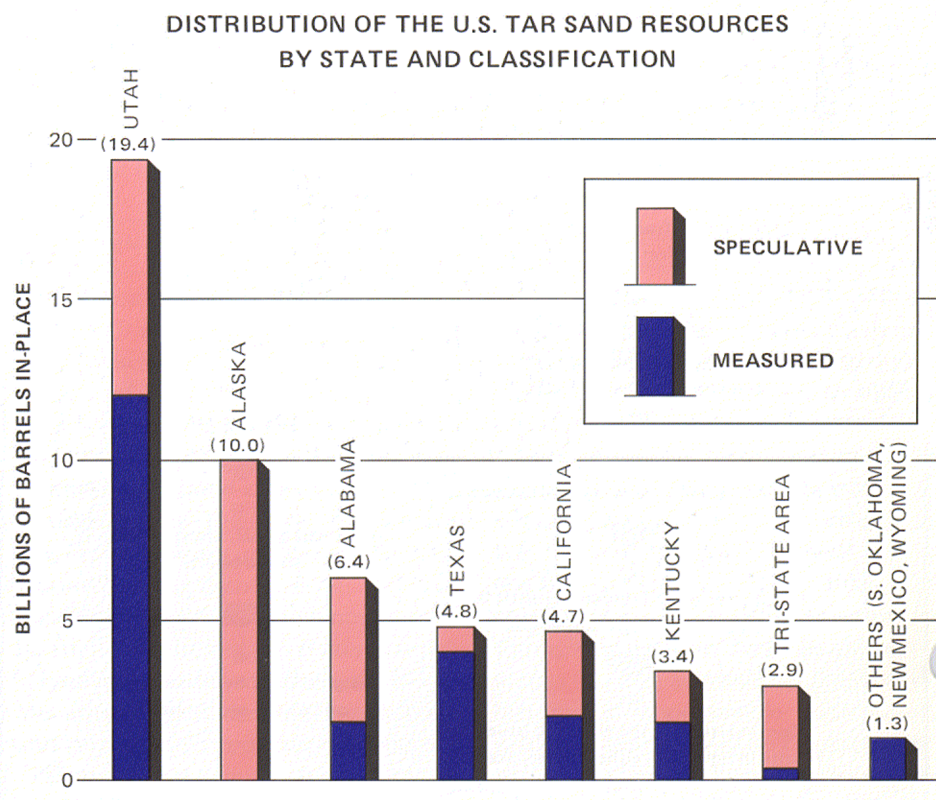


FIGURE 4. Distribution of the U.S. tar sand resources, by state and classification.

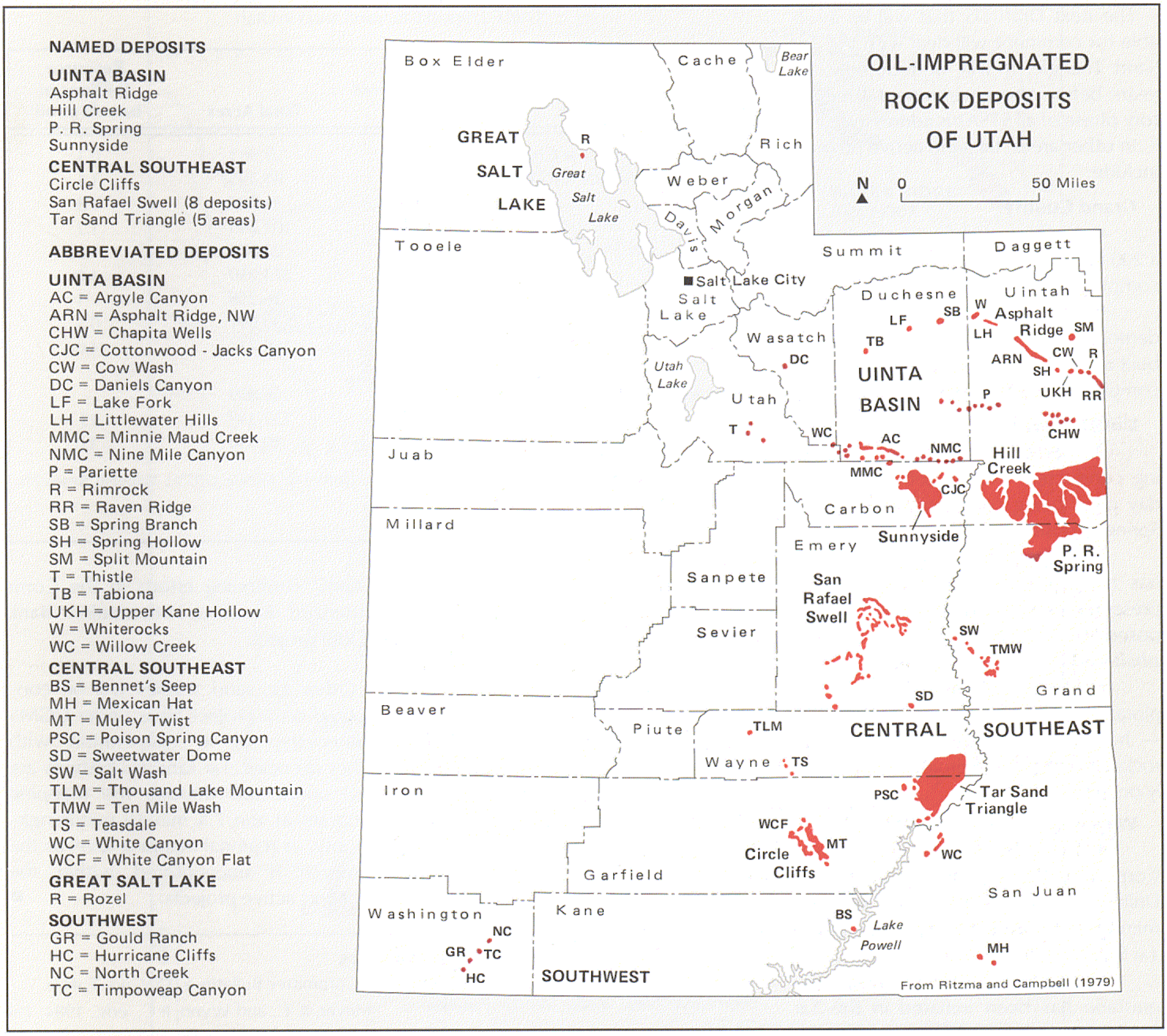


FIGURE 5. Geographic distribution of special tar sands areas in Utah.
(From Utah Combined Hydrocarbon — Draft Environmental Impact Statement.)

Table 2 lists the names, acreage, and reserves of the 11 STSAs. Figure 6 shows the geographic distribution of the areas; eight are in, or on the periphery of, the Uinta Basin. The other three are in southeastern Utah, north and west of the Colorado River.

Applicants seeking conversion of their oil and gas leases to combined hydrocarbon leases were required to file within two years of the November 16, 1982, enactment date or by the expiration date of their lease, whichever came first. The law also requires that an operating plan that ensures diligent development of the tar sands and reasonable protection of the environment must obtain Federal approval as a condition for lease conversions.

THE BLM has prepared two Environmental Impact Statements which are presently in draft form and are undergoing review and comment. The Regional Draft EIS addresses the broader aspects of all 11 STSAs. The Sunnyside CHL, Draft EIS is the first of the site-specific analyses to become available. Five companies have applied for conversion in the Sunnyside area:

— Amoco plans to convert seven leases totaling 9,602.08 acres.

— Chevron and Great National Corporation (GNC) propose to convert one lease totaling 160 acres.

— Enercor plans to convert three leases totaling 1,932.67 acres.

— Mono Power Company plans to convert seven leases totaling 9,836.1 acres.

— Sabine Production Company proposes to convert five leases totaling 7,240.04 acres.

The next Draft EIS that will be available for comment will deal with the Tar Sand Triangle. It will, undoubtedly, be years before the environmental regulatory phase of all STSAs is addressed.

In other areas, tar sand active projects include:

Grand County

- Big Horn Oil Company, Inc. — a 200 barrel per day pilot plant is nearing completion at the P.R. Spring deposit,
- C and A Companies, Inc. — a demonstration plant is proposed to be built at the P.R. Spring deposit; probable completion date sometime in 1984.

Uintah County

- Enercor — process testing is being conducted with a 5,000 barrel per day plant being considered for the P.R. Spring deposit.
- Sohio Shale Oil, Co. — a site has been acquired and technology is presently being developed for a proposed 20,000 barrel per day plant at *Asphalt Ridge*.
- Enercor, Rocky Mountain Exploration, and Hingeline Oil Company — have acquired a site for the Whiterocks project but the project is apparently on hold.

Wayne and Garfield Counties

- Santa Fe Energy Co., Altex Oil Corp., and Benson, Montin and Greer Drilling Co. — involved with environmental and regulatory processes in the Tar Sands Triangle.
- Hawthorne Oil Co. — lease acquisition has been initiated in the Tar Sand Triangle.
- Gulf Mineral Resources — lease acquisition has been undertaken and feasibility studies are being made in the Tar Sand Triangle.

Carbon County

- Chevron Resources, Inc. and Great National Corp. (GNC) — acquired a site and process testing is underway at the Sunnyside deposit.
- Mono Power Company — completed feasibility studies at the Sunnyside deposit.
- Enercor — completed feasibility studies at the Sunnyside deposit.
- Sabine Production Co. — involved in regulatory processes at the Sunnyside deposit.

TABLE 2. Special tar sand areas in Utah.

Special Tar Sand Areas	BLM Administered Acres	Total Acres	Resource (billions of barrels of oil)
Argyle Canyon/Willow Creek	12,877	21,963	0.1
Asphalt Ridge/White Rocks	13,169	41,395	1.1
Circle Cliffs	50,760	91,080	1.3
Hill Creek	7,932	107,249	1.2
Pariette	12,312	22,071	.02
P.R. Spring	183,346	273,950	4.0
Raven Ridge/Rum Rock	12,950	16,258	.1
San Rafael Swell	115,233	130,691	0.5
Sunnyside, southern	55,562 19,348*	169,734	4.0
Sunnyside, northern	33,043	56,809	
Tar Sand Triangle	83,400	157,339	13
White Canyon	8,085	10,536	3.0

Combined sources: Utah Combined Hydrocarbon Draft EIS; Ritzma (1979); National Research Council (1983).

*BLM does not control tar sand on these lands.

- Amoco Production Co. — completed feasibility studies at the Sunnyside deposit.

AT THE UGMS

A study of the tar sand potential of state lands in the P.R. Spring and Sunnyside areas was completed last spring and will be released for publication in 1984. Currently, studies are being conducted on the Tar Sand Triangle and San Rafael Swell deposits through the UGMS' continuing efforts in the Computerized Resource Information Bank (CRIB) project.

Other tar sand studies will be conducted on a project basis under UGMS sponsorship or in cooperation with other agencies. Tar sand evaluations are also conducted through the mapping program at the 7.5 minute quadrangle, county, or regional mapping level as the resource is encountered within the scope of active projects. ■

REFERENCES

Allinger, N. L., and others, 1971, Organic chemistry: New York, Worth Publishers, 1007 p.

Campbell, J. A., and Ritzma, H. R., 1979, Geology and petroleum resources of the major oil-impregnated sandstone deposits of Utah: Utah Geological and Mineral Survey Special Studies 50, 24 p.

Department of the Interior Bureau of Land Management, 1983, Sunnyside combined hydrocarbon lease conversion, draft EIS: 189 p.

Dott, R. H., Sr., and Merrill, J. R., 1969, Source book for petroleum geology: American Association of Petroleum Geologists Memoir 5, 471 p.

Eglinton, Geoffrey, and Murphy, J. T. J., eds., 1969, Organic geochemistry: New York, 824 p.

Hammershaimb, Edgar, 1983, Major tar sand and heavy oil deposits of the United States: Interstate Oil Compact Commission Committee Bulletin, v. XXV, no. 1, 44 p.

Meyer, R. F., and Wynn, J. C., eds., 1984, The future of heavy crude and tar sands: New York, McGraw-Hill, 1338 p.

National Research Council Committee on Onshore Energy Minerals Management, 1983, Research and information needs for management of tar sands development: Washington, D. C., National Academy Press, 30 p.

Partridge, Alan, and others, 1983, Utah combined hydrocarbon regional draft EIS: Department of the Interior Bureau of Land Management, v. I, II, III.

Ritzma, H.R., 1979, Oil-impregnated rock deposits of Utah (1979): Utah Geological and Mineral Survey Map 47, scale: 1:1000,000, two sheets.

Ritzma, H.R., and Campbell, J.A., 1979, Bibliography of oil-impregnated rock deposits of Utah: Utah Geological and Mineral Survey Circular 64, 18 p.

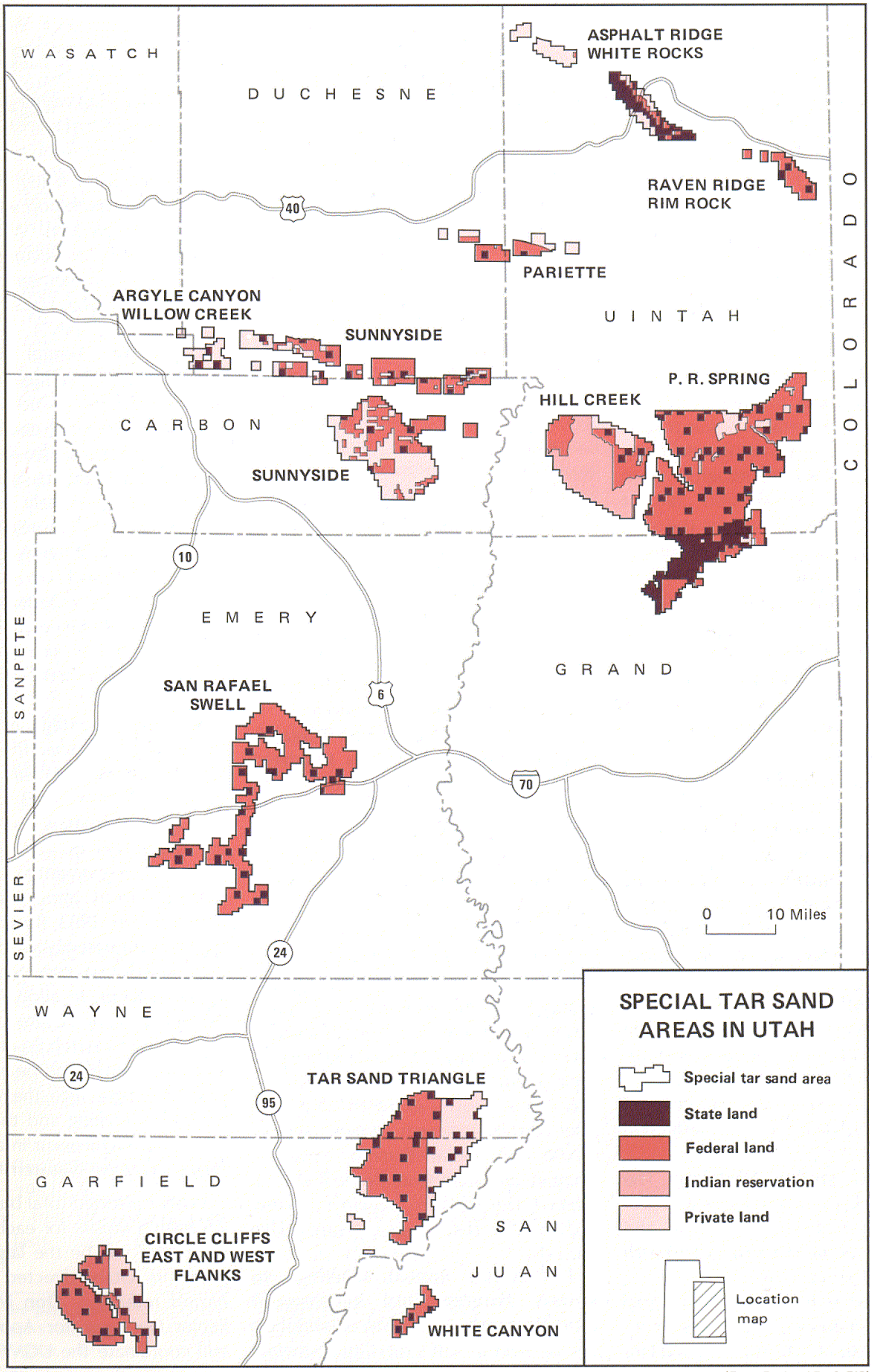
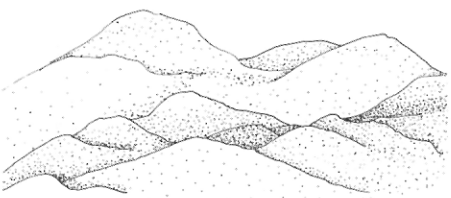

WASATCH
DUCHESNE
ASPHALT RIDGE
WHITE ROCKS
RAVEN RIDGE
RIM ROCK
40
PARIETTE
UINTAH
COLORADO
ARGYLE CANYON
WILLOW CREEK
SUNNYSIDE
P. R. SPRING
HILL CREEK
CARBON
SUNNYSIDE
10
EMERY
SANPETE
GRAND
SAN RAFAEL
SWELL
6
70
SEVIER
0 10 Miles
24
WAYNE
24
TAR SAND TRIANGLE
95
GARFIELD
SAN
JUAN
CIRCLE CLIFFS
EAST AND WEST
FLANKS
WHITE CANYON
SPECIAL TAR SAND AREAS IN UTAH
Special tar sand area
State land
Federal land
Indian reservation
Private land
Location map
(From Regional Draft EIS)

FIGURE 6.

THE NEW EARTHQUAKE PROGRAM

By Don R. Mabey



ON OCTOBER 1, 1983 the U.S. Geological Survey began a new program — Regional and Urban Earthquake Hazards Evaluation, Wasatch Front, Utah. This program, which is scheduled to run for three years, will involve several USGS scientists from Denver, Colorado and Menlo Park, California and other investigators supported through the USGS contract and grants program. The Utah Geological and Mineral Survey is participating with the USGS in the development of the program through a grant from the USGS and will also conduct scientific investigations under the program and work to implement actions to reduce the earthquake hazard.

The Regional and Urban Earthquake Hazards program for the Wasatch Front has five interrelated components:

1. Information Systems. The goal is to produce quality data along with a comprehensive information system, available to both internal and external users for use in earthquake hazards evaluations, risk assessment, and implementation of loss-reduction measures.

2. Synthesis of Geological and Geophysical Data for Evaluation of Earthquake Hazards. The goal is to produce synthesis reports describing the state-of-knowledge about earthquake hazards (ground shaking, surface faulting, earthquake-induced ground failure, and tectonic deformation) in the region and to recommend future research to increase the state-of-knowledge required for the creation and implementation of loss-reduction measures.

3. Ground Motion Modeling. The goal is to produce deterministic and probabilistic ground-motion models and maps of the ground-shaking hazard with commentaries on their use.

4. Loss Estimation Models. The goal is to devise economical methods for acquiring inventories of structures and lifeline systems in urban areas, to create a standard model and commentary for loss estimation, and to produce loss and casualty estimates for urban areas.

5. Implementation. The goal is to foster the creation and implementation of hazard-reduction measures in urban areas, providing high-quality scientific information that can be used by local government decisionmakers as a basis for "calling for change."

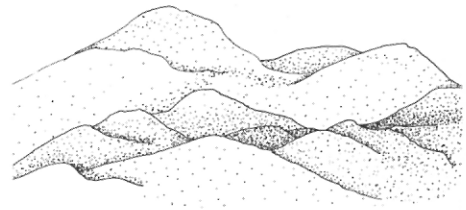
The strategies for the Wasatch Front study are:

1. Foster Partnership. USGS and UGMS will seek to foster strong partnerships with the universities, private sector, units of local government, and other State and Federal agencies. Existing partnerships will be strengthened.

2. Take Advantage of Past Research Studies and Other Activities. Results of past research studies will be utilized to the fullest extent possible. Achievements of the Utah Seismic Safety Advisory Council, the USGS-sponsored Earthquake Hazards Workshop of 1980, and the Governor's Conference on Geologic Hazards of 1983 will be used as building blocks for future activities.

3. Study Ten Counties Along the Wasatch Front. Although Salt Lake, Davis, Weber, and Utah Counties will receive the primary attention because of their population density, potential risk, and the availability of information from prior ongoing research studies, parts of Cache, Box Elder, Summit, Wasatch, Morgan, and Juab Counties will also be studied. The goal is to acquire a uniform, high quality data base on earthquake hazards.

4. Convene Annual Meetings to Review Progress and Recommend New Research. Each year, a workshop will be held in Salt Lake City to review what has been accomplished and what is still needed to accomplish the goals.



Participants from many different disciplines at the workshop will be asked to address the question "What changes, if any, are needed to accomplish the goals of the program element 'Regional and Urban Earthquake Hazards Evaluation: Wasatch Front, Utah'"?

5. Publish Annual Reports and Communicate Findings. Proceedings of the workshops, which will include papers documenting results from all research projects in the Wasatch Front, will be published as USGS Open-File Reports approximately three or four months after each meeting. In FY 86, the third year of the program, a USGS Professional Paper will be published. The workshops, their products, and the findings in the Professional Paper will be communicated to policymakers whose task is to implement hazard-reduction policy.

6. Take Advantage of Earthquakes. Use knowledge gained from earthquakes such as the Borah Peak, Idaho, earthquake of October 1983 to improve the methodology that is currently used in the evaluation of earthquake hazards and the assessment of risk in the Wasatch Front area. Many scientists consider the 1983 Borah Peak earthquake as representative of the type of earthquake that can occur along the Wasatch Front. In addition, other parts of the world have a similar tectonic setting to the Wasatch Front; earthquakes in these areas should be investigated to provide insight into the characteristics of ground shaking and the physical effects that might occur in a major earthquake along the Wasatch Front.

With a planned total budget of about 2.5 million dollars for each of the three years, this will be the largest-ever program in Utah directed at geologic hazard reduction. **Don Mabey**, UGMS Senior Geologist for Applied Geology, will coordinate the UGMS effort in the program and several other UGMS personnel will participate. ■

NEW UGMS PUBLICATIONS

- Map 70, **Utah Mining District Areas and Principal Metal Occurrences,** by Hellmut H. Doelling and Edwin W. Tooker, scale 1:750,000, 26" x 34", August 1983, five-colors, map folded; $5.00 over-the-counter.

- Map 71, **Non-metallic Mineral Resources of Utah,** by Hellmut Doelling, scale 1:750,000, 26" x 34", August 1983, five-colors, map folded; $5.00 over-the-counter.

- Map 72, **Geologic Map of the Pine Canyon Quadrangle, Carbon County, Utah,** by Paul B. Anderson, scale 1:24,000, 28" x 34", November 1983, two-colors, map folded in envelope, includes 14 p. of text, 2 figs., 5 tables, and 2 plates (folded); $7.50 over-the-counter.

- Special Studies 63, **Geothermal Assessment of a Portion of the Escalante Valley, Utah,** by Robert H. Klauk and Chad Gourley, 57 p., 32 figs., 5 tables; $7.50 over-the-counter.

- Circular 72, **Utah Mineral Industry Activity Review, 1981-82,** by Martha Ryder Smith, May 1984, 21 p., 7 figs., 17 tables; $3.00 over-the-counter.
  NOTE: The annual **Mineral Industry Activity Review** will be discontinued after this issue. Information about petroleum activity and production statistics in Utah can now be obtained from the Utah Division of Oil, Gas and Mining.

- Circular 74, **Governor's Conference on Geological Hazards,** December 1983, 99 p., viii, appendices; free of charge while supply lasts (add $1.50 for postage).

Orders must be pre-paid. Postage rates: Orders less than $10.00, add $1.50; $10.00 - $24.99, add $3.00; $25.00 - $100.00, add $5.00; more than $100.00, add $10.00; add $1.50 for tube for rolled map (maximum of four map sheets per tube).

ANNUAL INDEX

SURVEY NOTES, VOLUME 17, 1983

SUBJECT / ARTICLE	ISSUE NUMBER / PAGE
Coal	
Coal Petrology Short Course Announcement	No. 3, Page 11
Earthquakes	
Utah Earthquake Activity: October 1982 - March 1983	No. 1, Page 14
Utah Earthquake Activity: April - June 1983	No. 3, Page 13
G.K. Gilbert's Warning of Salt Lake City's Earthquake Hazard	No. 3, Page 2
New Earthquake Program	No. 4, Page 10
Great Salt Lake	
Great Salt Lake Level: Jan. 1 - April 15, 1983	No. 1, Page 10
Great Salt Lake Level: May 1 - July 15, 1983	No. 2, Page 16
Great Salt Lake Level: Aug. 1 - Nov. 15, 1983	No. 3, Page 15
Great Salt Lake Level: Dec. 1, 1983 - March 15, 1984	No. 4, Page 12
Hazards	
Reminder . . . Governor's Conference on Geologic Hazards	No. 1, Page 16
UGMS Responds to Disasters (From the Director's Desk)	No. 2, Page 2
Geologic Hazards of 1983	No. 2, Page 3
1982 and 1983 - Wet Years	No. 2, Page 3
Thistle Landslide	No. 2, Page 4
Wasatch Front Debris Flows	No. 2, Page 6
Hazards to and from Water Impoundments	No. 2, Page 6
Remote Sensing of Utah's "Wet-Period" Phenomena	No. 2, Page 12
USGS Helps Out	No. 2, Page 13
Governor's Conference on Geologic Hazards	No. 3, Page 11
Preparing for the Events of 1984 (From the Director's Desk)	No. 4, Page 2
Geologic Hazards of 1984	No. 4, Page 8
Minerals	
Mineral Resources of Utah	No. 1, Page 1
1981 Peak Mineral Activity Year in Utah	No. 1, Page 11
Mapping	
Wasatch Front Mapping Project	No. 3, Page 4
USGS Maps	No. 3, Page 10
Geology Mapping Survey	No. 3, insert
Miscellaneous	
Utah Geological and Mineral Survey Board (From the Director's Desk)	No. 1, Page 2
"CRIB" Reports Available	No. 1, Page 10
(Looking Backward) Elucidating the Uinta Range	No. 1, Page 12
Great Expectations	No. 1, Page 16
(Looking Backward) Edmund A. Spieker's Contribution to Utah Geology	No. 2, Page 9
NCIC State Affiliates Meet at UGMS	No. 3, Page 9
(Looking Backward) In the Land of Paradox	No. 3, Page 8
New Publications	
New Publications	No. 1, Page 10
New Publications	No. 3, Page 15
New Publications	No. 4, Page 11
Personalities	
Meet the Members of the UGMS Board	No. 1, Page 3
UGMS Staff Changes	No. 1, Page 16
UGMS Staff Changes	No. 2, page 15
Brent R. Jones Leaves UGMS	No. 3, Page 15
Clara War Retires	No. 3, Page 14
UGMS Staff Changes	No. 3, Page 14
UGMS Staff Changes	No. 4, Page 12
Petroleum	
Utah Tar Sands	No. 4, Page 3
Site Investigation	
The Davis County Experience	No. 2, Page 10
Heads Up	No. 3, Page 12

UGMS Staff Changes

The following staff changes have taken place since the last issue appeared:

Ginger Mattulat, former administrative assistant, has transferred to Social Services; **Vicki May** and **Gary Arndt** now job-share her position. Vicki has a bachelor's degree in education and is a master's candidate in public administration. She was involved in the initial development of Ticaboo township in southeastern Utah. Gary's bachelor's degree is in political science; he is also a candidate for a master's degree in public administration. He holds a Certificate of International Relations.

Carl Jacobs is the new accountant and comes to the Survey with 10 years of State accounting experience.

Typesetter and graphic artist **Nancy Close** has accepted a position in private industry, and **Linda Sapienza,** her co-worker, has moved to Canada. Replacements for these two employees are **Cathy Pinch,** originally from Illinois, with several years experience in the graphic arts industry as well as a double degree in business administration and philosophy; and **Carolyn Olsen,** a former secretary for the Survey. Carolyn's secretarial position is filled by **Roselyn Dechart,** a long-time resident of Bountiful with several years experience working for Davis County.

Harry Messenger, economic geologist, has also left the Survey and **Mike Shubat** fills his position. Mike received his bachelor's degree from the University of Minnesota and master's from Washington State.

Cathy Nanz transferred from the job-share receptionist position to full time in the hazards section. **Janine Jarva** now fills that position while she works on her bachelor's degree in geology.

Bob Klauk, who has been in charge of the geothermal project until it ended recently, is now with the applied program.

Dale Broadhurst, former senior cartographer in the editorial section, is serving with the Peace Corps in Nepal. **Jessie Roy** has moved into his position, and **James Parker** has taken Jessie's place.

The UGMS appreciates the many **geotechs** who do part-time and temporary work. They are not mentioned in the staff changes because there are so many and their terms are usually brief, but their work is vital to our organization and they are missed when they leave.

GREAT SALT LAKE LEVEL

Date (1983)	Saline North Arm (in feet)	Boat Harbor South Arm (in feet)
December 1*	4202.50	4205.05
December 15*	4202.75	4205.40
January 1*	4203.10	4205.90
January 15	4203.40	4206.15
February 1	4203.60	4206.30
February 15	4204.80	4206.50
March 1	4204.10	4206.70
March 15	4204.20	4206.85

* These elevations reflect the corrections made due to a gradual settling of the Boat Harbor gage and a resurvey of the Saline gage.
Source: USGS Water Level Records.

UTAH GEOLOGICAL AND MINERAL SURVEY

SURVEY NOTES

State of Utah . . . . Scott M. Matheson
Governor

Department of Natural Resources . . . . Temple A. Reynolds
Executive Director

Utah Geological and Mineral Survey . . . . Genevieve Atwood
Director

Editor . . . . Klaus D. Gurgel

Editorial Staff . . . . Cathy Pinch
Carolyn Olsen

Cartographers . . . . Jessie S. Roy
Kent D. Brown, James W. Parker

UTAH NATURAL RESOURCES
Utah Geological and Mineral Survey
606 Black Hawk Way
Salt Lake City, UT 84108-1280

Address correction requested

Bulk Rate
U.S. Postage Paid
S.L.C., Utah
Permit No. 4728

Account No. 6120
Approval No. P840078